PTO 09-4169

CC=JP DATE=20010921 KIND=A
PN=2001254755

YOKE OF UNIVERSAL JOINT
[JIZAITSUGITENO YOKU]

SEKINE HIROSHI

UNITED STATES PATENT AND TRADEMARK OFFICE
Washington, D.C. April 2009

Translated by: FLS, Inc.

PUBLICATION COUNTRY	(19):	JP
DOCUMENT NUMBER	(11):	2001254755
DOCUMENT KIND	(12):	A
PUBLICATION DATE	(43):	20010921
APPLICATION NUMBER	(21):	2000-065364
DATE OF FILING	(22):	20000309
ADDITION TO	(61):	
INTERNATIONAL CLASSIFICATION	(51):	F16D 3/26
PRIORITY	(30):	
INVENTOR	(72):	SEKINE HIROSHI
APPLICANT	(71):	NSK LTD
DESIGNATED CONTRACTING STATES	(81):	
TITLE	(54):	YOKE OF UNIVERSAL JOINT
FOREIGN TITLE	[54A]:	JIZAITSUGITENO YOKU

[Claims /*

[Claim 1] A yoke of a universal joint formed by cold forging and machining which comprises a tightening portion which is a cylindrical section with a shaft hole opened in one end for inserting shaft, therein having

a bolt hole for tightening and fixing with bolts, a U-shaped arm portion located on the opposite side of this tightening portion having a bearing hole at its end for connecting with the other yoke, and

a body portion that integrates this arm portion with the tightening portion.

The width of said arm portion in the plane orthogonal to the axial direction of the shaft-bearing hole equals the diameter of said shaft bearing hole plus (2.9~4.0 mm) x 2. If the width of this arm portion is set to 1, the outside diameter of the body portion, as well as the width of the tightening portion in the direction parallel to the axial direction of the holt hole, is set to a ratio of 0.95~1.07.

Further, if the diameter of said body portion is set to 1, the diameter of said shaft hole is set to ratio of 0.6~0.76.

[Detailed Description of the Invention]

[0001] [Technical Field of Invention]

This invention relates to a yoke of a universal joint that is

---

* Claim and paragraph numbers correspond to those in the foreign text.

used for such purposes as an automobile steering device, is made by cold forging and machining, and has a tightening portion for tightening and fixing the shaft.

[0002] [Prior Art]

In general, a steering device that imparts a steering angle to the front wheels of an automobile is configured so that the movement of the rotating steering shaft from the operation of the steering wheel is transmitted to the input shaft of the steering gear via a spider type universal joint. This universal joint pivotally holds a pair of yokes together via a spider cross shaft.

[0003] The yoke making up this universal joint is formed by a process of cold forging. Cold forging is a process that can manufacture products with excellent size accuracy, surface, and strength swiftly without making scraps. On the other hand, however, it requires materials with few impurities and surface scratches, having excellent ductility and size accuracy. Additionally, it also requires pre-processing such as heat and lubrication treatment. Further, the molding die requires personnel with sophisticated skills and years of experience who can design and manufacture molds that can withstand high pressure and wear.

[0004] Since there is a demand for a lighter yoke of a universal joint that maintains the required strength, lean yokes having reinforced structure are being manufactured by a cold forging process. Such a yoke comprises a tightening portion for tightening

bolts to mount said shaft and an arm portion having the bearing hole (bearing press fitting hole), wherein an uneven thickness portion is formed on one side of the tightening portion in the axial direction of the shaft. In order to produce the yoke with this structure, as shown in Figure 9, the rough mold material 42 of the arm portion made from preliminary rough mold material by swaging process is placed in a dice 32 of a press forging machine having an uneven thickness forming section 33 to form an uneven thickness section on one side only, then load is applied on the punch 36 for swaging to create the tightening portion 25.

[0005] However, an uneven thickness section is formed on one side of the tightening portion 25. Thus, although there is not much of a problem if the gap between the bearing hole and the tightening portion is small, if this gap is relatively large, the uneven thickness section must also be elongated, resulting in a heavier product and not inductive to one reducing the weight.

[0006] Further, since in the cold forging, the form of the tightening portion after forming the arm portion would have an even section on one side only, it was easy to buckle when the load was applied to the punch 36. For example, as shown in Figure 9, if we let the diameter of the arm portion rough molding material 42 be ‘d,’ the length of the tightening portion 25 of the rough mold material for swaging process be ‘L,’ it is necessary that ‘L’ satisfy $L/d>1.5$ in order to form the uneven thickness section. In such a case, however,

as shown in Figure 10, the stress by the load (arrow) of the punch 36 cannot be dispersed, and would concentrate on the side for uneven thickness section formation 33, which could trigger buckling 35, making the formation impossible.

[0007] Thus, under JP-B (Tokko) H06-058124, as shown in Figure 11, the tightening portion 11 has an uneven thickness section 11c on one side of the end section 11a located on the opposite side of the arm portion 24, and has the body portion 11b which is made by extending this end section 11a in the direction of the arm portion 24. Since the back section of cut 26 (see Figure 12) located at the uneven thickness section 11c forms a protruding section 11d that protrudes farther outside than the back surface 11f of the side opposite to the cut in the body portion 11b, even when the gap between the bearing hole 27 and the tightening portion 11 of the arm portion is large, the forming process of the tightening portion 11 by a cold forging would expand the side of the uneven thickness section 11c of the rough molding material as well as the protrusion 11d at the opposite side of the uneven thickness section 11c outward, which prevents buckling. Further, it is possible to produce a shape with leaner uneven thickness section 11c. This enables a lightweight yoke of a universal joint that has excellent strength and size accuracy. Here, the width of the arm portion 24 of this yoke (vertical width in the figure) is smaller than the outside diameter of the body portion 11b, and the outer diameter 11b of the body portion and the width in

the axial direction of the bolt of the uneven thickness section 11c are set to the same value as shown in Figure 12.

[0008] [Problems to be Resolved by the Invention]

However, with the conventional yoke of the universal joint above, the ratios among the width of the arm portion 24, the outer diameter of the body portion 11b, the width of the uneven thickness section 11c, and the diameter of the serration hole 15 for inserting the shaft were not clearly defined. Thus, some specifications used to result in poor strength balance, and some components used to result in excessive quality. Thus, not only were the material costs high, but also the weight used to be excessive because of such components as the protrusion 11d. Further, as shown in Figure 12, the roll off section 24a at the tip of the arm portion 24 was difficult to form by cold forging and required machining, which also increased costs.

[0009] Thus, the aim of this invention is to resolve the above problems and to provide a lightweight yoke of a universal joint with excellent strength balance for a low cost.

[0010] [Means for Solving the Problems]

In order to achieve the above objective, this invention proposed a yoke of a universal joint formed by cold forging and machining which has a tightening portion which is a cylindrical section with a shaft hole opened on one end for inserting a shaft therein having a bolt hole for tightening and fixing with bolts, a U-shaped arm portion located on the opposite side of this tightening portion

having a bearing hole at its end for connecting with the other yoke, and a body portion that integrates this arm portion with the tightening portion. The width of said arm portion in the plane orthogonal to the axial direction of the shaft bearing hole equals the diameter of said shaft bearing hole plus (2.9~4.0 mm) x 2. If the width of this arm portion is set to 1, the outside diameter of the body portion, as well as the width of the tightening portion in the direction parallel to the axial direction of the holt hole, is set to a ratio of 0.95~1.07. Further, if the diameter of said body portion is set to 1, the diameter of said shaft hole is set to a ratio of 0.6~0.76. By setting the components of the yoke with the balanced sizes, it is possible to obtain balance among component strength and as well as the minimum necessary structure, which would reduce the weight.

[0011] [Embodiment]

One embodiment of this invention is explained using illustrating drawings. Figure 1 is a cross-sectional view of the flat section of the yoke of a universal joint showing the first embodiment of this invention. Figure 2 is a side view as seen Figure 1 from direction 'A.' Figure 3 is a side view of a universal joint that connects a pair of yokes. Figure 4 is a cross-sectional view at B-B in Figure 1. Figure 5 is a view of Figure 1 as seen from direction C. Figure 6 is a cross-sectional view of the flat section of the yoke of a universal joint showing the second embodiment of this invention. Figure 7 is a

partial cross-sectional view of Figure 6 as seen from direction D. Figure 8 is a cross-sectional view at E-E of Figure 6.

[0012] The universal joint in Figure 3 is for connecting a steering shaft comprising the steering device of an automobile, having a structure connecting a pair of yokes 1 and 12. The shaft 10 fixed on the yoke 1 side is connected to the steering wheel side, while the shaft 22 fixed on the yoke 12 side is connected to the steering gear side.

[0013] The yoke 1 and yoke 12 are connected in a mutually rotatable manner at the end section of the arms 2 and 23 by a spider (cross joint) 17 composed from two orthogonal shafts via bearing (needle bearing) 15. A resin thrust piece 18 is mounted at the end of the spider 17, which determines the position of the spider 17 in the axial direction. The bearing 15 is mounted on the arm section 2 and 23 by pressure fitting into the bearing hole 6 and by caulking 16. The diameter of the shaft of the spider 17 is about 10 mm. The shaft 10 in inserted into the tightening portion 4 of the yoke 1, and is tightened and secured by bolt 11 via washer 19. Similarly, the shaft 22 is tightened and secured in the yoke 12 by bolt 11.

[0014] The yoke 1 above is an integrated unit made, as shown in Figure 1 and Figure 2, from a pair of arms 2 and 2′ forming a U-shape, a tightening section 4 on the other end side, and the body portion 3 between these arms 2 and 2′ and the tightening sections 4a and 4b. This yoke 1 uses JIS Machine Structure Carbon Steel S10C~S38C

as its material.

[0015] In the vicinity of the tips of the pair of arms 2 and 2′ are respective bearing holes 6. The inside diameter of the bearing hole 6 is about 15~16 mm. The thickness P at the tip of arms 2 and 2′ in the axial direction is about 3~4 mm, and the thickness Q in the direction orthogonal to this axial direction is about 2.9~4.0 mm, roughly the same. With this structure, the rigidity around bearing hole 6 would become almost uniform, reducing deformation during manufacturing and improving hole accuracy (cylindricity). The width L of the arm 2 and 2′ at the flat section orthogonal to the axial direction of the bearing hole 6 is set to the size equal to the inside diameter of the bearing hole 6 plus (2.9~4.0 mm) x 2. Thus, if the inside diameter of the bearing hole 6 is 16 mm, the arm width would be 21.8~24.0 mm. As shown in Figure 5, the back clearance 13 of the tip of arms 2 and 2′ is for easy insertion of the spider 17 (see Figure 3) into the bearing hole 6, and is formed in a rough arc shape centered at the axial center of the serration hole 5. This back clearance 13 could be in a rectangular or elliptical shape (not shown). The chamfer 14 and 14 provided at both side edges of the arm 2′ from the base section to the middle of the length direction are clearance to allow a larger bending angle of the universal joint. The angle of the chamfer 14 and 14 against the side surface of the arm 2 and 2′ is 28~36°. The distance T between arms 2 and 2′ is about 41.5 mm.

[0016] Opposite to the tightening portion 4a and 4b are bolt hole 9 and screw hole 8 (see Figure 4). The distance from the center of the bearing hole 6 to the side surface of the tightening portion 4 is about 70 mm. The bolt threadably mounted in the screw hole 8 uses M8 of JIS B205.

[0017] The body portion 3 is formed in a cylindrical shape with an opening at the end of the tightening portion 4 and having a serration hole (shaft hole) 5 to house the shaft 10 (see Figure 3) within. The inside diameter of the serration hole 5 is about 14.0~17.8 mm. As shown in Figure 2, a slit 7 is provided, extending from the tightening portion 4 to roughly the middle of the body portion 3, in the axial direction of the shaft 10. The width of the slit 7 is 2~4 mm.

[0018] As shown in Figure 1, Figure 2, and Figure 4, when the width of the arm is set equal to 1, the outside diameter M of the body portion 3 and the width N of the tightening portion 4 are set to the ratio of 0.95~1.07. Further, when the outside diameter of the body portion 3 is set to 1, the ratio of the diameter of the serration hole 5 is set to 0.6~0.76. The outside diameter M of the body portion 3 and the width N of the tightening portion 4 are roughly the same size. By setting the length S of the tightening portion 4 to 20 mm, it is not necessary to provide counter boring on the seat surface 20, and it is possible to secure a seat surface for a spring clip plate for the bolt (JIS B1251 nominal designation 8),

leading to cost cutting.

[0019] The screw hole 8 is formed by a machining process. The bolt hole 9, serration hole 5, slit 7, end face 21 of the tightening portion 4, bearing hole 6, and chamfer 14 are formed either by machining process or cold forming. Other components are formed by cold forging. The clearance 13 at the tip of arms 2 and 2' are formed in a rough arc shape centered at the axial center of the serration hole 5 or in rectangular or elliptic shape, these can be formed by cold forging.

[0020] The yoke 1 of the above configuration was used to conduct numerous experiments and to carry out finite element method analysis. The result showed that the strength of components is balanced and it is possible to securely tighten and fix the shaft 10 by tightening the bolt 11. Thus, it is possible to obtain a lightweight yoke whose material cost is low. Further, since the clearances at the ends of the arms 2 and 2' are formed in rough arc shape or in rectangular or elliptic shape, they can be formed by cold forging, which contributes to lowing cost.

[0021] The second embodiment is explained using Figure 6 ~ Figure 8 as reference. In Figure 6, Figure 7, and Figure 8, this embodiment is roughly the same as the first embodiment above. The same components are assigned the same numbers. The difference is that the tightening portion 34 of the yoke 31 is formed by rotating the tightening portion 4 of yoke 1 by 90° around the axial center of

shaft 10. Further, the length of the yoke 31 in the axial direction of the shaft 10 is slightly shorter than with yoke 1 with the shorter body portion 3.

[0022] The yoke 31 with this configuration, as was with the first embodiment, has balanced strength of components, and the weight has been reduced by the amount of the shortened body portion 3. The position of the rotation direction of the tightening portion 24 around the axial center of the shaft 10 is not limited to what was shown in the first and second embodiments, and could be set to any position freely. However, as shown in Figure 3, the bolt-tightening process is simplified during assembly on the vehicle when the positions of the tightening portions of the yoke 1 and the yoke 12 are oriented in the same direction.

[0023] [Advantageous Effect of the Invention]

As explained above, this invention has set the width of the flat section of the arm portion orthogonal to the axial direction of the bearing hole to equal the diameter of the bearing hole plus (2.9~4.0 mm) x 2. Let the width of this arm portion be equal to 1, then set the ratio of outer diameter of the body portion and the width of the tightening portion parallel to the axial direction of the bolt hole be to equal 0.95~1.07. Let the outer diameter of the body portion be 1, then the diameter of the shaft hole is set to the ratio of 0.6~0.76. This configuration provides a shape of a minimum necessary shape with balanced strength of components of the yoke, and makes it

possible to securely tighten and fix the shaft by tightening the bolts. Therefore, with this invention, it is possible to obtain a sufficiently lightweight and low cost yoke.

[Brief Description of the Figures]

[Figure 1] The partial cross-sectional view of the yoke of the universal joint of the first embodiment of this invention.

[Figure 2] The side view of the yoke in Figure 1 as seen from the direction of the arrow A.

[Figure 3] The side view of the universal joint connecting two yokes of the first embodiment of this invention.

[Figure 4] A cross-sectional view of the yoke in Figure 1 at B-B.

[Figure 5] The side view of the yoke in Figure 1 as seen from the direction of the arrow C.

[Figure 6] The partial cross-sectional view of the yoke of the universal joint of the second embodiment of this invention.

[Figure 7] The partial cross-sectional view of the yoke in Figure 6 as seen from the direction of the arrow D.

[Figure 8] A cross-sectional view of the yoke in Figure 6 at E-E.

[Figure 9] Illustrates how rough mold material is set in the conventional yoke.

[Figure 10] Illustrates how buckling happens with the conventional yoke.

[Figure 11] A side view of the conventional yoke.

[Figure 12] Illustrates the clearance at the tip of the conventional yoke.

[Explanation of codes]

1 … Yoke

2 … Arm portion

3 … Body portion

4 … Tightening portion

5 … Shaft hole (serration hole)

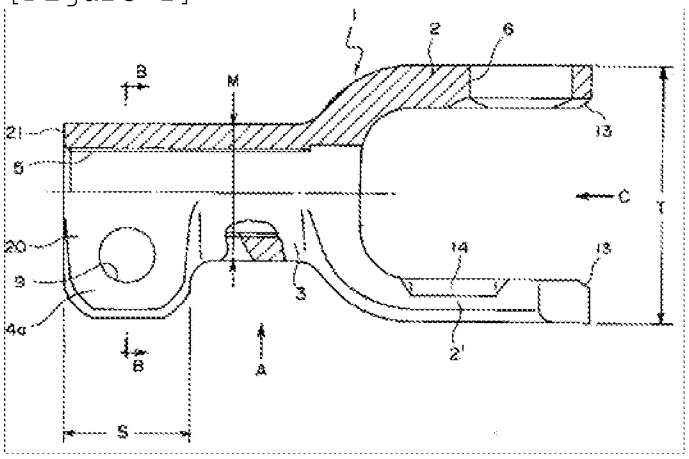
6 … Bearing hole

7 … Slit

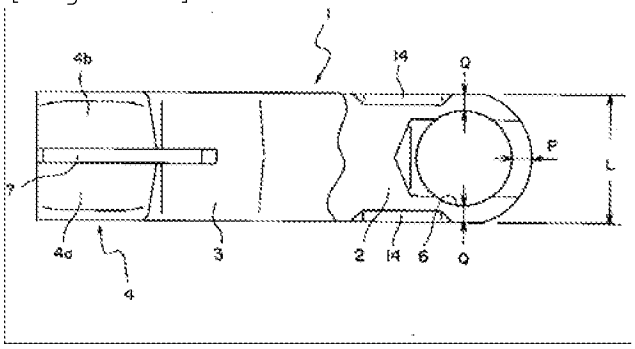
9 … Bolt hole

10 … Shaft.

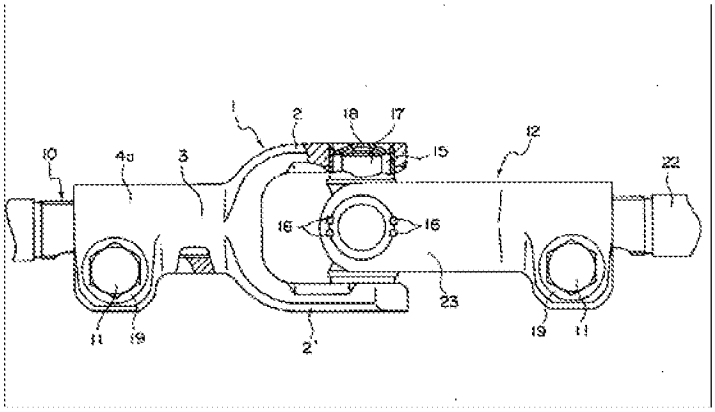
[Figure 1]



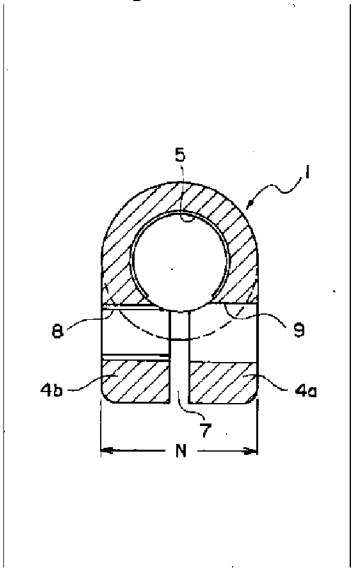
[Figure 2]



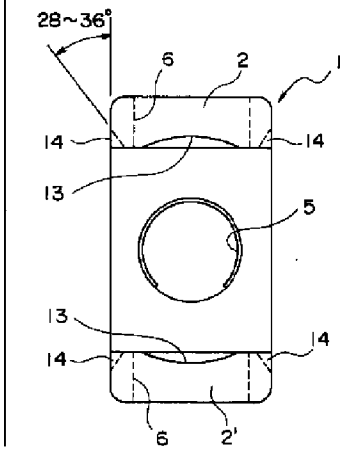
[Figure 3]



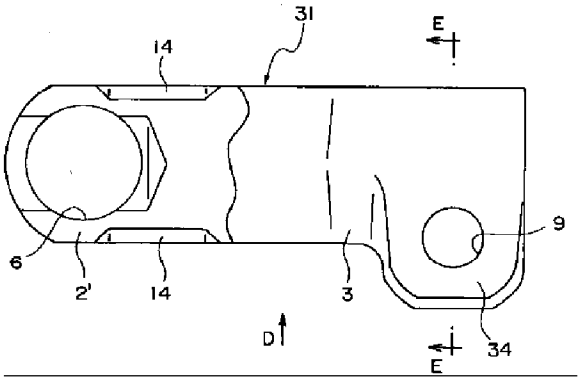
[Figure 4]



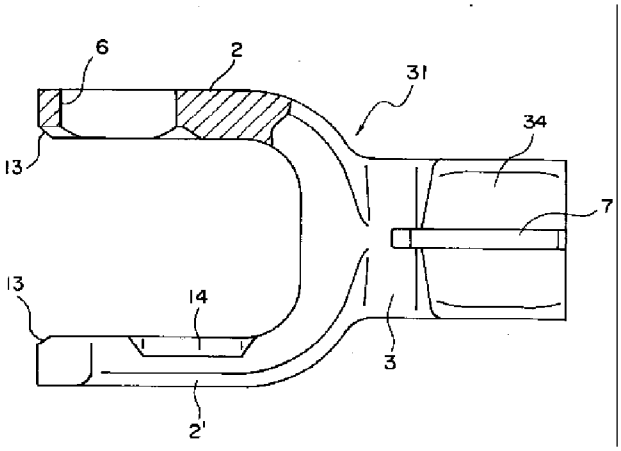
[Figure 5]



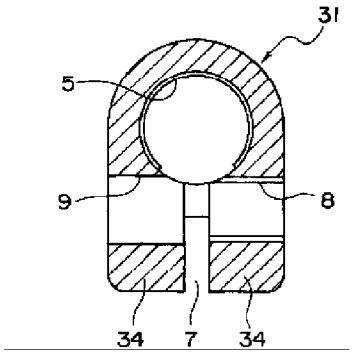
[Figure 6]



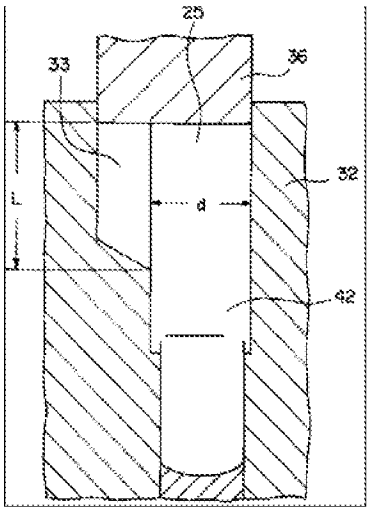
[Figure 7]



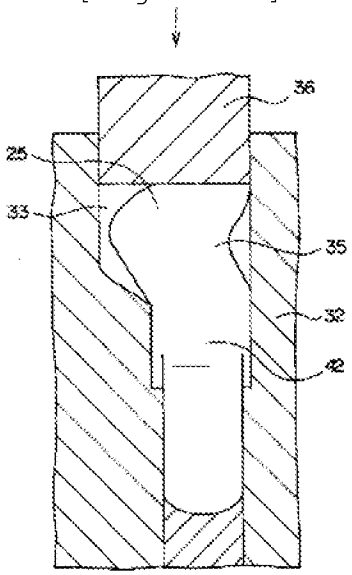
[Figure 8]



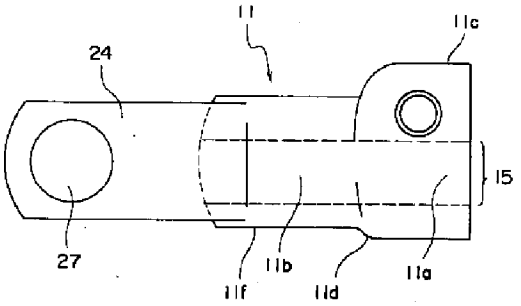
[Figure 9]



[Figure 10]



[Figure 11]



[Figure 12]